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COMPLETE SPECIFICATION

Improvements in Screw Threaded Unions for Tubular Members

We, PHOENIX-RHEINROHR A.G., Vereinigte Hutten-und Rohrenwerke, a German Company, of Dusseldorf, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to screw threaded unions for the liners or casings used in lining bore holes, especially for very deep holes drilled when boring for oil.

Deep bore holes are generally lined with chains or trains of tubular liners which seal and support the walls of the bore hole. The liners are suspended in the bore hole in such a manner that the upper tubular liner sections carry the entire weight of the chain or train of tubular liner sections which are suspended beneath them.

The liner tubes are interconnected by means of screw threads and the screw threaded part of the liners are the weak spots of the chain or train of liners as known hitherto and break down under heavy load sooner than the non-threaded parts of the liners.

The object of the present invention is to provide a screw threaded union for tubular liners or casings which has substantially the same resistance to breakage under heavy loads as the unthreaded or smooth parts of the liner and which not only does not involve extra cost in production or material but also lowers such cost.

Screw threaded unions for tubular liners must have two important characteristics, that is they must be capable of being screwed together easily and quickly and must provide a tight seal against both inner and outer pressure. Many attempts have been made to achieve these results but so far without complete success. Normal threads have been introduced and become widely used but have not fulfilled the above mentioned requirements. In one known form of threaded union the depth of the thread is varied at each end of the tube in such a manner that, progressing from an end of the tube inwards, there is first a zone in which the depth of the thread gradually increases until the maximum depth is achieved in the central zone, and then decreases through an inner zone, the height of the teeth corresponding to the depth of the thread.

Numerous experiments carried out by the applicants have established that the main difficulty in producing a satisfactory threaded liner coupling is to find a way of ensuring that the load to be carried is distributed equally over all the threads and at the same time to maintain the same powers of resistance to load at the threaded portions as at the unthreaded portions. One possible solution of this problem might reside in cutting a conical thread in the non-reinforced ends of the tube in such a manner that the thickness of the tube wall increases continuously from zero to maximum thickness and the depth of the thread converges towards zero. Threads with this kind of depth however are not feasible from the manufacturing point of view. Furthermore, there is a limit to the diminution of the thickness of the wall at the ends of the tube in practice owing to the necessity of keeping the coupling sturdy enough to withstand rough handling in the oil fields. Based on the experiences gained in these experiments, the applicant has produced a threaded coupling for tubular bore liners which achieves the object of the present invention.

According to the invention, the threaded union is characterised in that one tube is provided with a conical coarse thread having substantially radial carrying flanks the remaining flanks or the crowns of the thread being convexly curved, as seen in axial section and adapted to contact tangentially, when relieved of load, corresponding flanks or crowns of the counterthread of the other tube which are rectilinear as seen in an axial

section. The term "carrying flanks" is applied to those flanks of the thread which carry the axial load.

The base of the thread and the crown of the thread may have straight linear outlines in axial section and form cone surfaces which are parallel to the basic cone of the thread. The thread has a coarse pitch, for example four threads per 25.4 mm. in a tube of 139.7 mm. and a relatively small depth for example 1.5 mm. in a 139.7 mm. tube, whereas the comparable union "A.P.I." standard of the American Petroleum Institute has a depth of thread of 1.8 mm. (These measurements have been converted into the metric system from the customary inch measurements which explains the fractional character of these data). The edges at the foot of the radial flanks are more pronouncedly rounded off than the edges at the top of the radial flanks, so that they enclose a small hollow space between them. The threads are modelled on a basic cone angle of between 1:8 and 1:16, e.g. 1:10 (angles expressed as ratios of cone diameters to cone heights).

As is well known, the entire sum of forces acts upon the first and/or the last threads when the screws are loaded. It has been established that the same phenomenon occurs also in threaded unions. The forces acting when a threaded union is loaded are widening or expanding and bending forces, the widening or expanding forces being evoked by the shape of the known threaded unions and the bending forces caused by the distances between the points of attack of these forces and the neutral axis of the parts of the threads.

Owing to the use of radial carrying flanks in the threads according to the present invention, the widening or expanding forces are reduced to a minimum, but the bending forces can not be completely eliminated.

To begin with, the use of a coarse thread brings about a shear resistance which is higher than in the customary fine threads. This shear resistance is further increased considerably by the use of radial carrying flanks. Apart from the radial carrying surface of a thread according to the invention, one further surface only can be used and fixed as a carrying element. For this reason and in order to achieve the maximum shear resistance, the oblique flank of the coarse thread according to one embodiment of the invention is convexly shaped or curved whilst the corresponding oblique flank of the counter-thread is straight-lined in axial section, that is conical in three-dimensional terms. When tightening the thread by hand, spot contact, seen in an axial section, will occur at first on the vertical and oblique flank of the thread. The spot contact on the vertical flank is caused by the unavoidable inaccuracy of machining, and on the oblique flank, by design, owing to its spherical or curved shape. It is immaterial in this connection whether it is the oblique flanks of the inner or of the outer thread which are spherical-shaped. The scoring of the union will be prevented in either case owing to the described arrangements.

The following considerations may help to explain this phenomenon: Were it possible to screw together a union according to the present invention without friction, only radial forces having a widening effect would come into action. These forces are resolved perpendicularly to the contact planes, so that, on the union being screwed together with force, the oblique flanks will carry the main load. If the load be considerable, the convex flank is deformed so that in axial section the contact is linear instead of punctiform, but the edges are not pressed so as to cause scoring. It therefore becomes thus possible to screw the union together with a considerable force, to achieve a high degree of tightness, and to tension the thread considerably, which is very advantageous if and when tensile stresses occur.

Various embodiments will now be described by way of example with reference to the accompanying drawings wherein:—

Figure 1 is an axial section through a threaded union for liners according to the invention;

Figure 2 a similar section through a part of the same union on a larger scale, and

Figure 3 a section, corresponding to Figure 2, through a modified type of the threaded union.

Referring now to these drawings, two liner tubes 1 and 2 are provided respectively with internal and external conically threaded parts 3 and 4 which are in engagement with each other. The load carrying flanks 6 of the external threads are disposed radially, and the likewise radially disposed load carrying flanks 5 of the internal threads bear against them. The oblique flanks 7 of the internal thread have a convexly curved shape and, as seen in an axial section, have a point contact with the oblique flanks 13 of the outer thread which are rectilinear as seen in an axial section.

The crowns 11 of the threads and the bases 12 thereof are, seen in an axial section, rectilinear and disposed on cone surfaces which are parallel to the basic cone a—a of the threads. From the manufacturing point of view this feature has the advantage that the threads can be easily controlled, because the rectilinear surfaces, in contrast with curved surfaces, can easily be measured. The surfaces 11 and 12 are machined with the customary tolerances.

The outer edges 9 between the radial flank and the thread crown 11 are rounded off;

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The base of the thread and the crown of the thread may have straight linear outlines in axial section and form cone surfaces which are parallel to the basic cone of the thread. The thread has a coarse pitch, for example four threads per 25.4 mm. in a tube of 139.7 mm. and a relatively small depth for example 1.5 mm. in a 139.7 mm. tube, whereas the comparable union "A.P.I." standard of the American Petroleum Institute has a depth of thread of 1.8 mm. (These measurements have been converted into the metric system from the customary inch measurements which explains the fractional character of these data). The edges at the foot of the radial flanks are more pronouncedly rounded off than the edges at the top of the radial flanks, so that they enclose a small hollow space between them. The threads are modelled on a basic cone angle of between 1:8 and 1:16, e.g. 1:10 (angles expressed as ratios of cone diameters to cone heights).

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Various embodiments will now be described by way of example with reference to the accompanying drawings wherein:—

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Figure 2 a similar section through a part of the same union on a larger scale, and

Figure 3 a section, corresponding to Figure 2, through a modified type of the threaded union.

Referring now to these drawings, two liner tubes 1 and 2 are provided respectively with internal and external conically threaded parts 3 and 4 which are in engagement with each other. The load carrying flanks 6 of the external threads are disposed radially, and the likewise radially disposed load carrying flanks 5 of the internal threads bear against them. The oblique flanks 7 of the internal thread have a convexly curved shape and, as seen in an axial section, have a point contact with the oblique flanks 13 of the outer thread which are rectilinear as seen in an axial section.

The crowns 11 of the threads and the bases 12 thereof are, seen in an axial section, rectilinear and disposed on cone surfaces which are parallel to the basic cone a—a of the threads. From the manufacturing point of view this feature has the advantage that the threads can be easily controlled, because the rectilinear surfaces, in contrast with curved surfaces, can easily be measured. The surfaces 11 and 13 are machined with the customary tolerances.

The outer edges 9 between the radial flank and the thread crown 11 are rounded off;

their radius of curvature being twice or three times greater than the radius of curvature of the edges 8 of the counterthread between the radial flank and the thread base 12, so that a small free space 16 is left to accommodate deformations, without any harmful consequences, which may occur if the union is exposed to an excessive stress. The radii of curvature of the edges 14 and 10 between the thread base 12 and the oblique flank 7 and/or the thread crown 11 and the oblique flank 13 are for example in the ratio of 8:6, the radius of curvature of the edge 8 having the value of 1. These figures for the above mentioned ratio are in the form of dimensionless parameters and thus when the radius of curvature of the edge 8 has the value 1, the radius of curvature of the edge 14 assumes the value 8, and the radius of curvature of the edge 10 assumes the value 6. If for example the radius of curvature of the edge 8 is 15 mm., then the radius of curvature of the edge 14 is 120 mm., and the radius of curvature of the edge 10 is 90 mm.

At its inward ends the thread according to the invention is so machined that it merges into the full cross-section of the tube wall, a part of the thread being incomplete, i.e. the form of the thread continues unaltered but the cone of the thread converges towards the outer surface of the tube. A substantial advantage of this feature of the invention is that at both ends of the union incompletely formed threads are used for load transmission, which thus takes place in parts of the pipe ends which are not as yet weakened by the full depth of the thread.

Owing to the particularly advantageous characteristics of the union according to the invention, such as a smaller degree of decrease in wall thickness in comparison with the smooth parts of the pipes, the thread can have a smaller depth than was hitherto customary. Thus for example the thread in a 139.7 mm. diameter pipe may, according to the invention, have a depth of 1.5 mm., whilst the corresponding standard thread has a depth of 1.8 mm.

The pitch of the thread according to the invention is larger than that of the hitherto customary unions, for example four threads per 25.4 mm. in a 139.7 mm. diameter pipe as compared with eight or ten threads per 25.4 mm. in standard threads for 139.7 mm. pipes. This feature facilitates speedier screwing together, thus reducing correspondingly the time needed for assembling.

Other embodiments, besides those described above, are of course possible without departing from the scope of the present invention as defined by the appended claims. Thus for example the ratios of the lengths of the oblique flanks 7 and/or 13 to the lengths of the thread crowns 11 and/or the thread base 12 can be varied. Furthermore, as shown in Figure 3, the oblique flank 15 can be rectilinear as seen in an axial section and the thread crown 17 on one tube convexly curved, whilst the thread base 18 is rectilinear as seen in an axial section. In this embodiment the thread crowns 17 and the thread base 18 are elongated as shown and the oblique flanks 15 shortened.

What we claim is:—

1. A screw threaded union for tubular liners or casing, especially for deep bore holes, characterised in that one tube is provided with a conical coarse thread having substantially radial carrying flanks, the remaining flanks or the crowns of the threads being convexly curved as seen in axial section and adapted to contact tangentially, when relieved of load, corresponding flanks or crowns of the counterthread of the other tube which are rectilinear as seen in an axial section.

2. A screw threaded uion according to Claim 1, characterised in that the crowns and the bases of the thread, as seen in an axial section, are rectilinear and correspond to the surfaces of cones which are parallel to the basic cone of the thread.

3. A screw threaded union according to Claim 1 or 2, characterised in that the inward ends of the threads merge into the tube wall so that the not fully shaped threads also serve for load transmission.

4. A screw threaded union according to any one of the Claims 1 to 3, characterised in that the thread has a depth of 1.5 mm. for example, in a tube of 139.7 mm. diameter.

5. A screw threaded union according to any one of Claims 1 to 4, characterised in that the pitch in a 139.7 mm. diameter tube has between 3 and 6, preferably 4, threads per 25.4 mm.

6. A screw threaded union according to any one of Claims 1 to 5, characterised in that the outer edges between the thread crown and the radial flank have a radius of curvature which is twice to three times greater than the radius of curvature of the corresponding edges of the counterthread between the thread base and the radial flank.

7. A screw threaded union according to any one of Claims 1 to 6, characterised in that the basic cone angle of the thread is between 1:8 and 1:16, preferably 1:10 (angles expressed as ratios of cone diameters to cone heights).

8. A screw threaded union for tubular members comprising an external conical screw thread on one tube end adapted to engage an internal conical screw thread on the other tube end, wherein the thread on each tube end is provided with a substantially radial flank, a crown, a base part and an oblique flank joining said crown and base

portions, the oblique flank or the crown portion of the thread on one tube end having a convex surface, when seen in axial section, co-operating with, so as to contact tangentially, a rectilinear oblique flank or rectilinear crown portion of the thread on the other tube end.

9. Screw threaded pipe unions having screw threads substantially as herein described with reference to Figure 2 or Figure 3 of the accompanying drawings.

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777,901 COMPLETE SPECIFICATION

1 SHEET

This drawing is a reproduction of the Original on a reduced scale.

Fig. 1

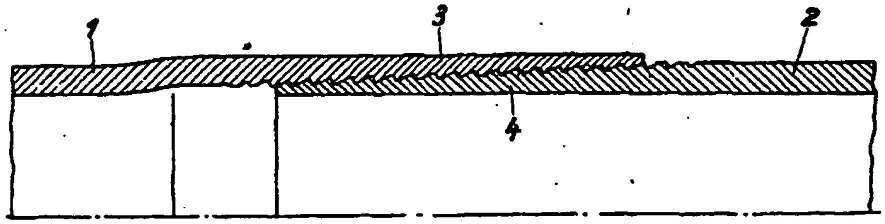

Fig. 2

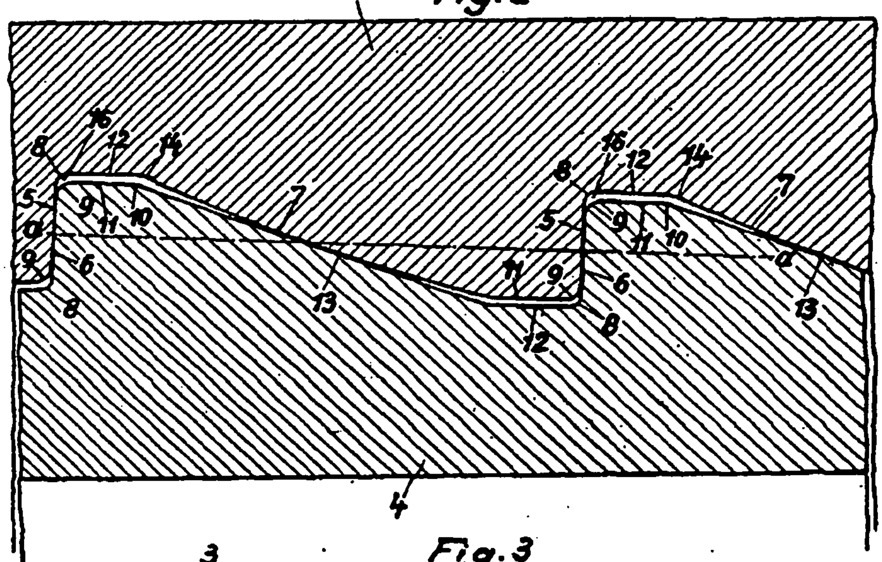

Fig. 3